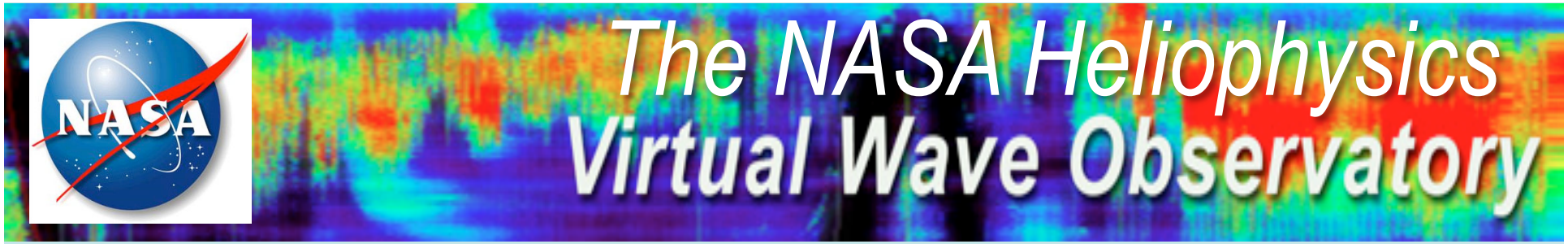


# A Portal for Searching and Accessing Heliophysics Wave Data

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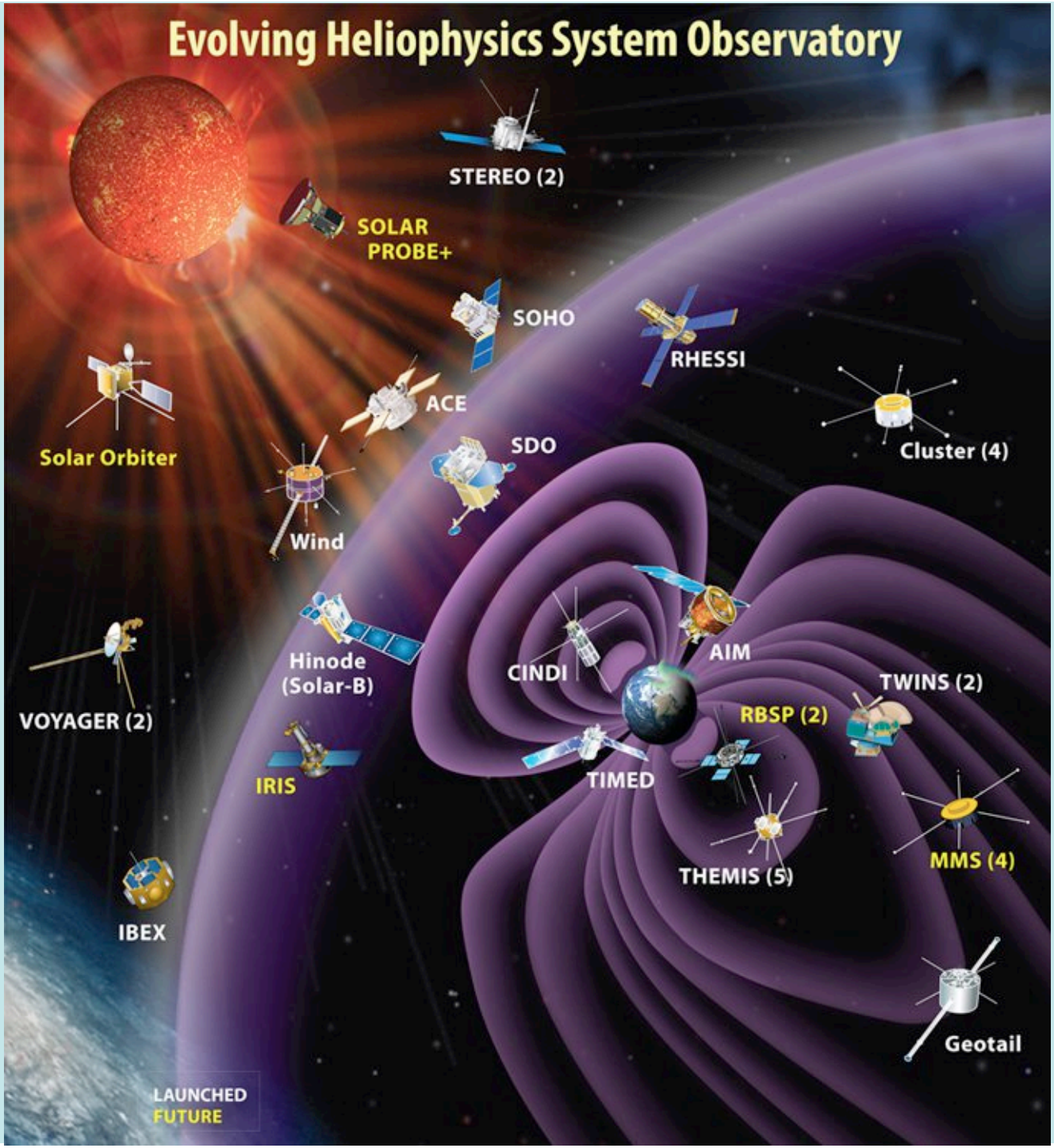
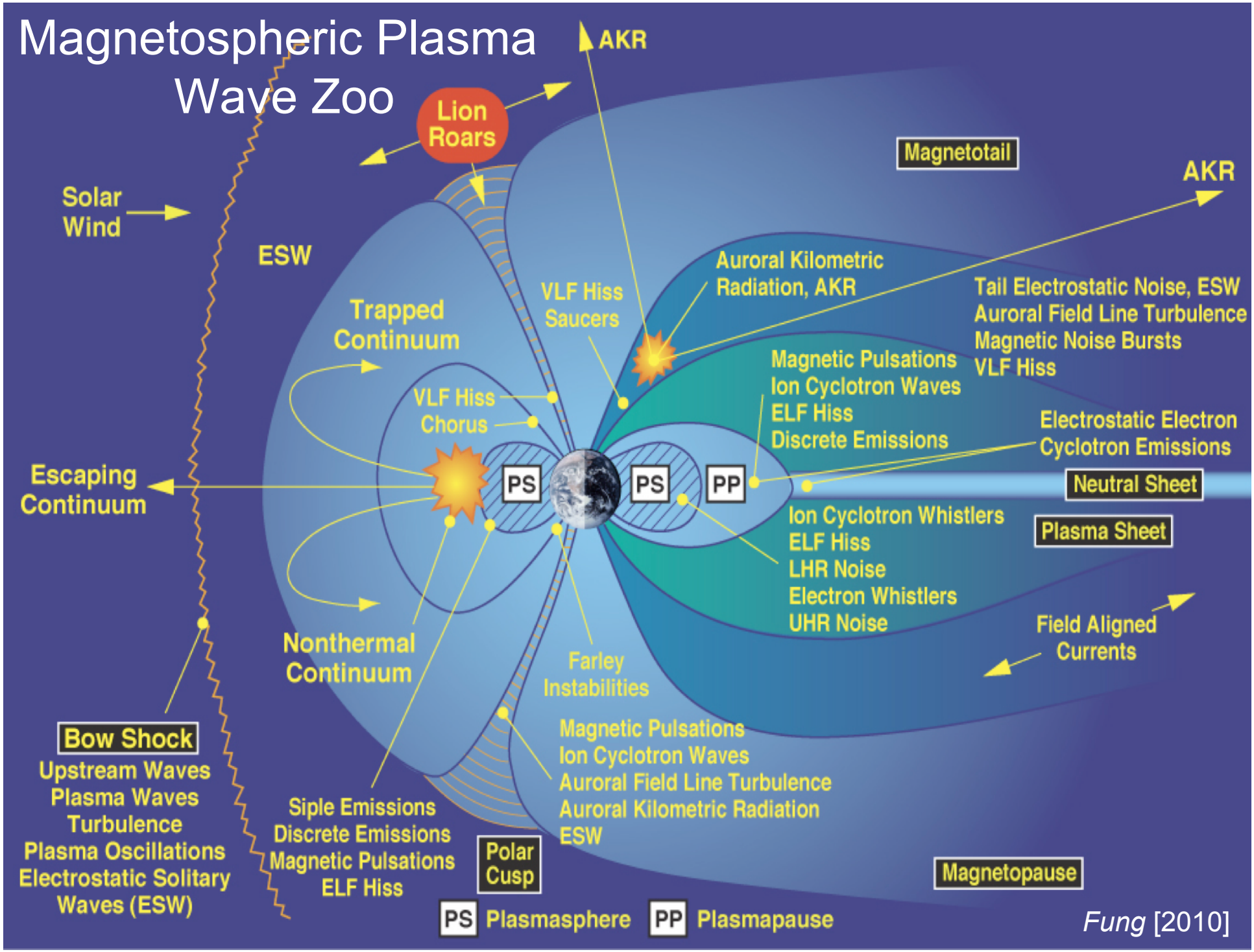
Presented at the CAWSES-II Symposium, Nagoya, Japan, November 18-22, 2013


Evolving Heliophysics System Observatory
STEREO (2)
SOLAR PROBE+
SOHO
RHESSI
ACE
Solar Orbiter
SDO
Cluster (4)
Wind
Hinode (Solar-B)
AIM
CINDI
TWINS (2)
VOYAGER (2)
RBSP (2)
IRIS
TIMED
MMS (4)
THEMIS (5)
IBEX
Geotail
LAUNCHED
FUTURE


Magnetospheric Plasma Wave Zoo
AKR
Lion Roars
Magnetotail
AKR
Solar Wind
ESW
Auroral Kilometric Radiation, AKR
Tail Electrostatic Noise, ESW
Auroral Field Line Turbulence
Magnetic Noise Bursts
VLF Hiss
VLF Hiss Saucers
Trapped Continuum
Magnetic Pulsations
Ion Cyclotron Waves
ELF Hiss
Discrete Emissions
VLF Hiss
Chorus
Electrostatic Electron Cyclotron Emissions
Escaping Continuum
PS
PS
PP
Neutral Sheet
Ion Cyclotron Whistlers
ELF Hiss
LHR Noise
Electron Whistlers
UHR Noise
Plasma Sheet
Nonthermal Continuum
Farley Instabilities
Field Aligned Currents
Bow Shock
Upstream Waves
Plasma Waves
Turbulence
Plasma Oscillations
Electrostatic Solitary Waves (ESW)
Magnetic Pulsations
Ion Cyclotron Waves
Auroral Field Line Turbulence
Auroral Kilometric Radiation
ESW
Siple Emissions
Discrete Emissions
Magnetic Pulsations
ELF Hiss
Polar Cusp
Magnetopause
PS Plasmasphere
PP Plasmapause

*Fung* [2010]

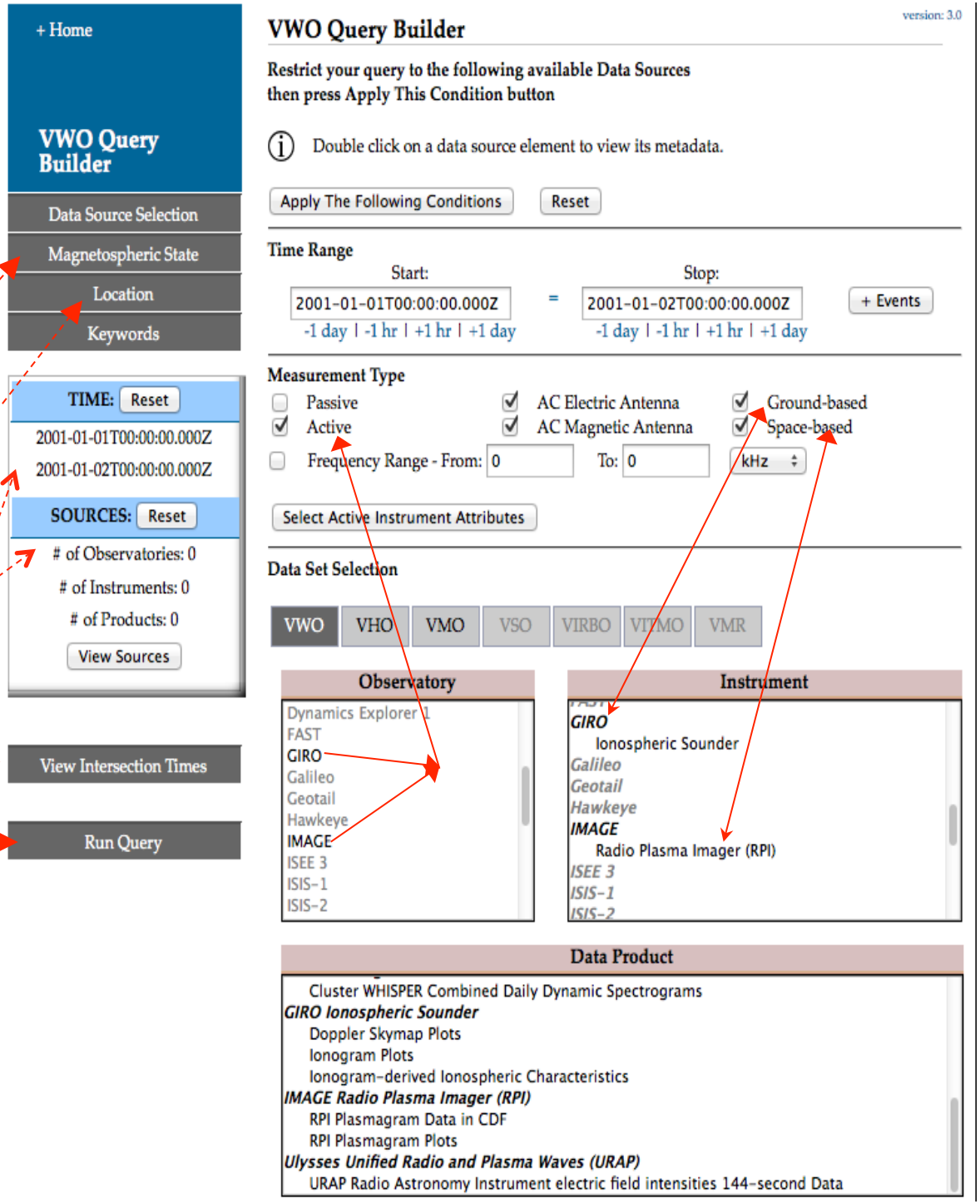
# The *VWO*

A component of the *NASA Heliophysics Data and Model Consortium* (*HDMC*) that:

- Focuses on serving heliophysics wave data, enabling *searchability*, *understandability,* and *usability* of all (online-accessible, distributed) heliophysics wave data
- Covers all heliophysics domains
  - Waves are everywhere
  - *VWO* supports all heliophysics disciplines
- Is "SPASE inside" for
  - Data set registration
  - Data querying

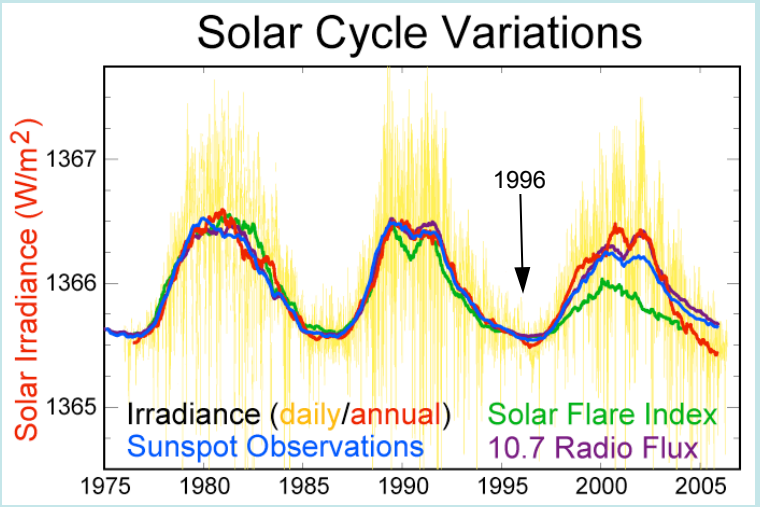
# Query Builder

- Main data query/search interface
- Traditional searches by
  - Time
  - Platform (ground/space-based)
  - Instrument
- Higher order searches by
  - Magnetospheric state
  - Observing platform locations
  - Keywords/annotation (TBD)
- Query conditions summary
- Intersection times
- Run Query to activate data search through remote data repositories and return data files or metadata files

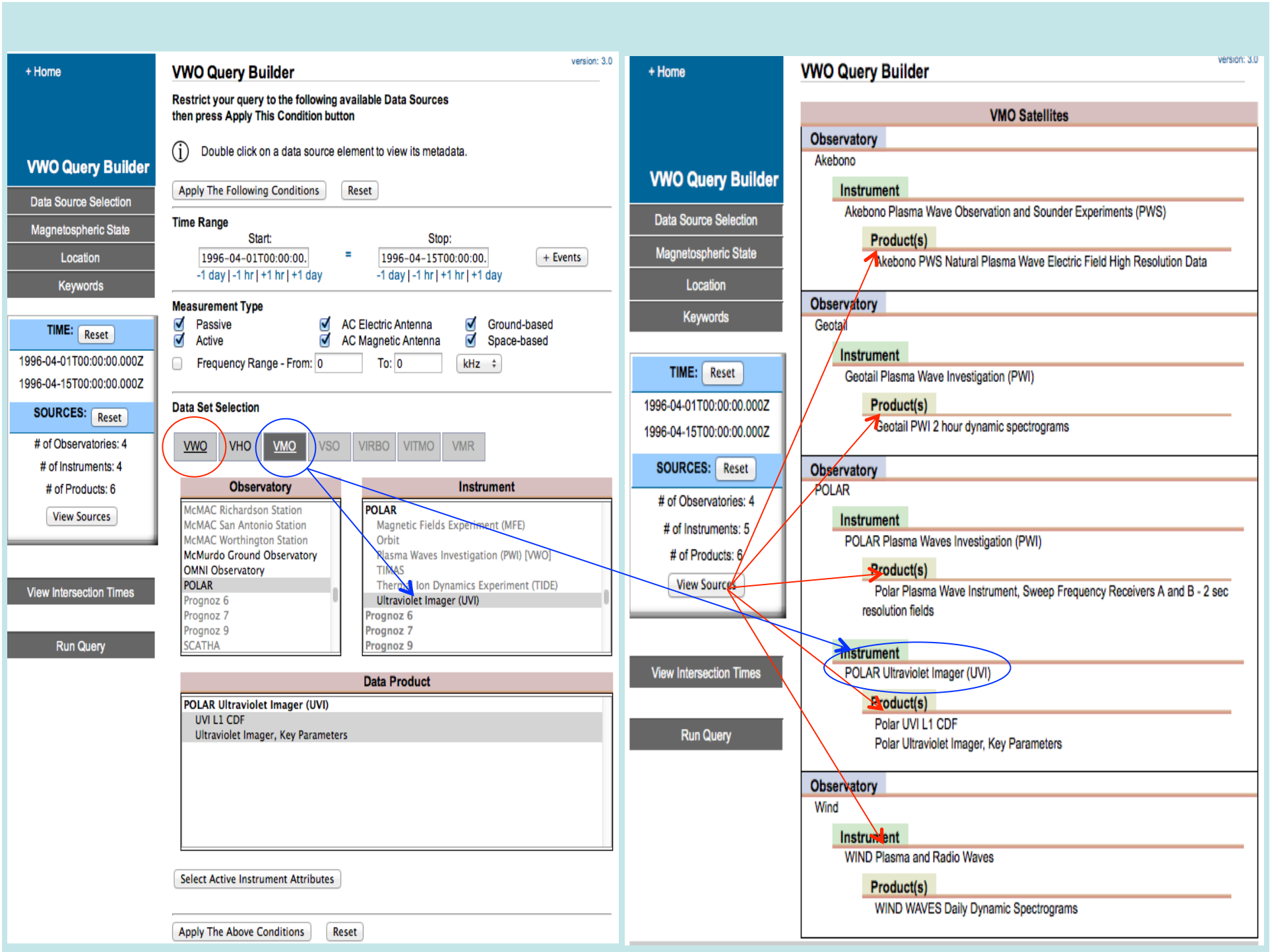


# Example 1: Studying AKR with multi-mission data

- Study the auroral kilometric radiation (AKR) during a solar minimum using *Akebono*, *Geotail*, *Polar*, and *Wind* data
- Data from all satellites are available in 1996, *e.g.*, April 1-15, 1996.
- Search for AKR observations by satellite at different locations, such as:
  - *Akebono* in the northern hemisphere & on the night side
  - *Polar* in the northern hemisphere




[*from http://en.wikipedia.org/wiki/Solar_cycle*]


+ Home
VWO Query Builder
Data Source Selection
Magnetospheric State
Location
Keywords
TIME: Reset
1996-04-01T00:00:00.000Z
1996-04-15T00:00:00.000Z
SOURCES: Reset
# of Observatories: 4
# of Instruments: 4
# of Products: 6
View Sources
View Intersection Times
Run Query
version: 3.0
VWO Query Builder
Restrict your query to the following available Data Sources
then press Apply This Condition button
Double click on a data source element to view its metadata.
Apply The Following Conditions
Reset
Time Range
Start:
1996-04-01T00:00:00.
-1 day | -1 hr | +1 hr | +1 day
=
Stop:
1996-04-15T00:00:00.
-1 day | -1 hr | +1 hr | +1 day
+ Events
Measurement Type
Passive
Active
AC Electric Antenna
AC Magnetic Antenna
Ground-based
Space-based
Frequency Range - From: 0 To: 0 kHz
Data Set Selection
VWO
VHO
VMO
VSO
VIRBO
VITMO
VMR
Observatory
McMAC Richardson Station
McMAC San Antonio Station
McMAC Worthington Station
McMurdo Ground Observatory
OMNI Observatory
POLAR
Prognoz 6
Prognoz 7
Prognoz 9
SCATHA
Instrument
POLAR
Magnetic Fields Experiment (MFE)
Orbit
Plasma Waves Investigation (PWI) [VWO]
TIMAS
Thermal Ion Dynamics Experiment (TIDE)
Ultraviolet Imager (UVI)
Prognoz 6
Prognoz 7
Prognoz 9
Data Product
POLAR Ultraviolet Imager (UVI)
UVI L1 CDF
Ultraviolet Imager, Key Parameters
Select Active Instrument Attributes
Apply The Above Conditions
Reset
+ Home
VWO Query Builder
Data Source Selection
Magnetospheric State
Location
Keywords
TIME: Reset
1996-04-01T00:00:00.000Z
1996-04-15T00:00:00.000Z
SOURCES: Reset
# of Observatories: 4
# of Instruments: 5
# of Products: 6
View Sources
View Intersection Times
Run Query
version: 3.0
VWO Query Builder
VMO Satellites
Observatory
Akebono
Instrument
Akebono Plasma Wave Observation and Sounder Experiments (PWS)
Product(s)
Akebono PWS Natural Plasma Wave Electric Field High Resolution Data
Observatory
Geotail
Instrument
Geotail Plasma Wave Investigation (PWI)
Product(s)
Geotail PWI 2 hour dynamic spectrograms
Observatory
POLAR
Instrument
POLAR Plasma Waves Investigation (PWI)
Product(s)
Polar Plasma Wave Instrument, Sweep Frequency Receivers A and B - 2 sec resolution fields
Instrument
POLAR Ultraviolet Imager (UVI)
Product(s)
Polar UVI L1 CDF
Polar Ultraviolet Imager, Key Parameters
Observatory
Wind
Instrument
WIND Plasma and Radio Waves
Product(s)
WIND WAVES Daily Dynamic Spectrograms

**Exercising location search:**

**Akebono**

20 < Lat (GSM) < 80,

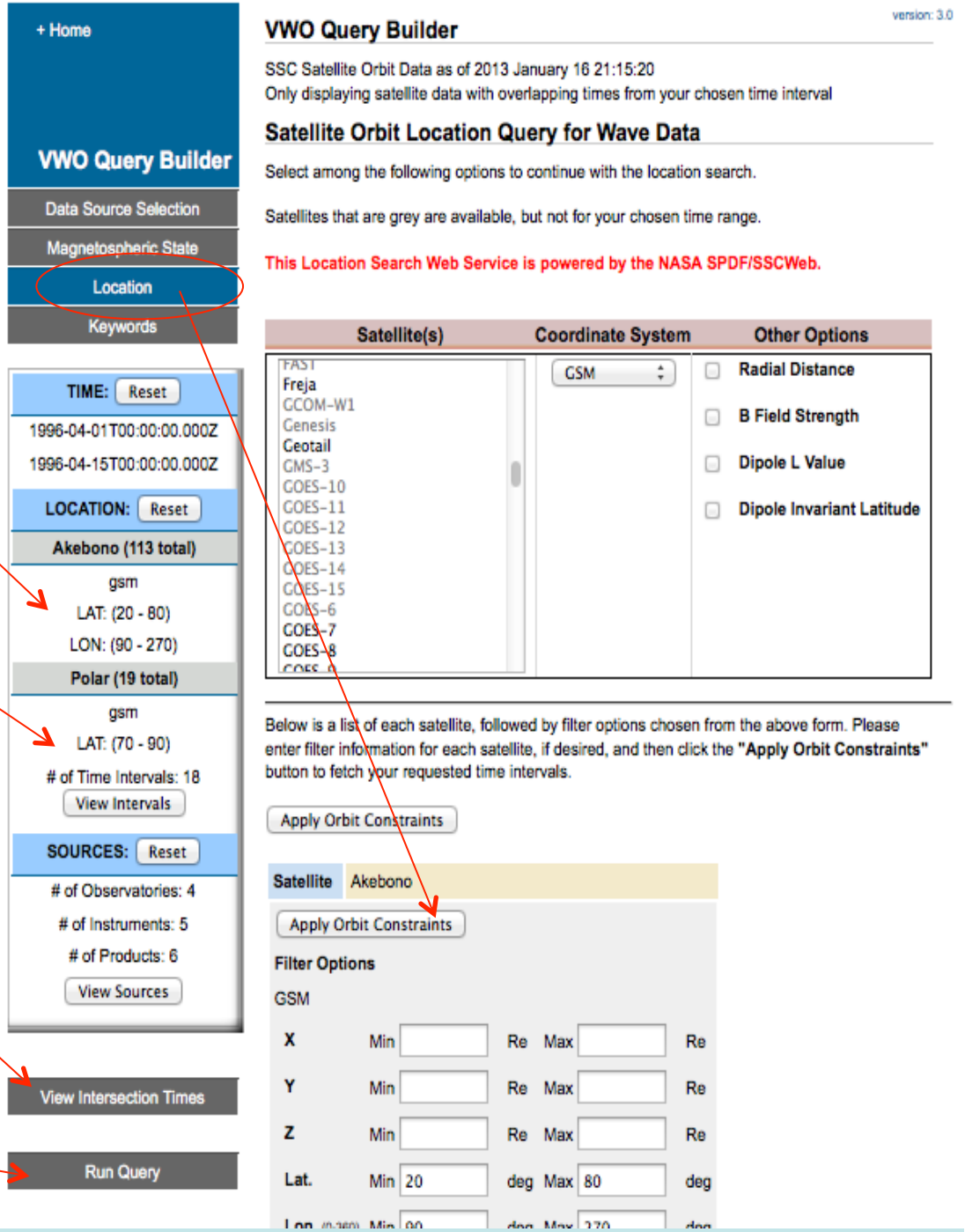
90 < Long (GSM) < 270,

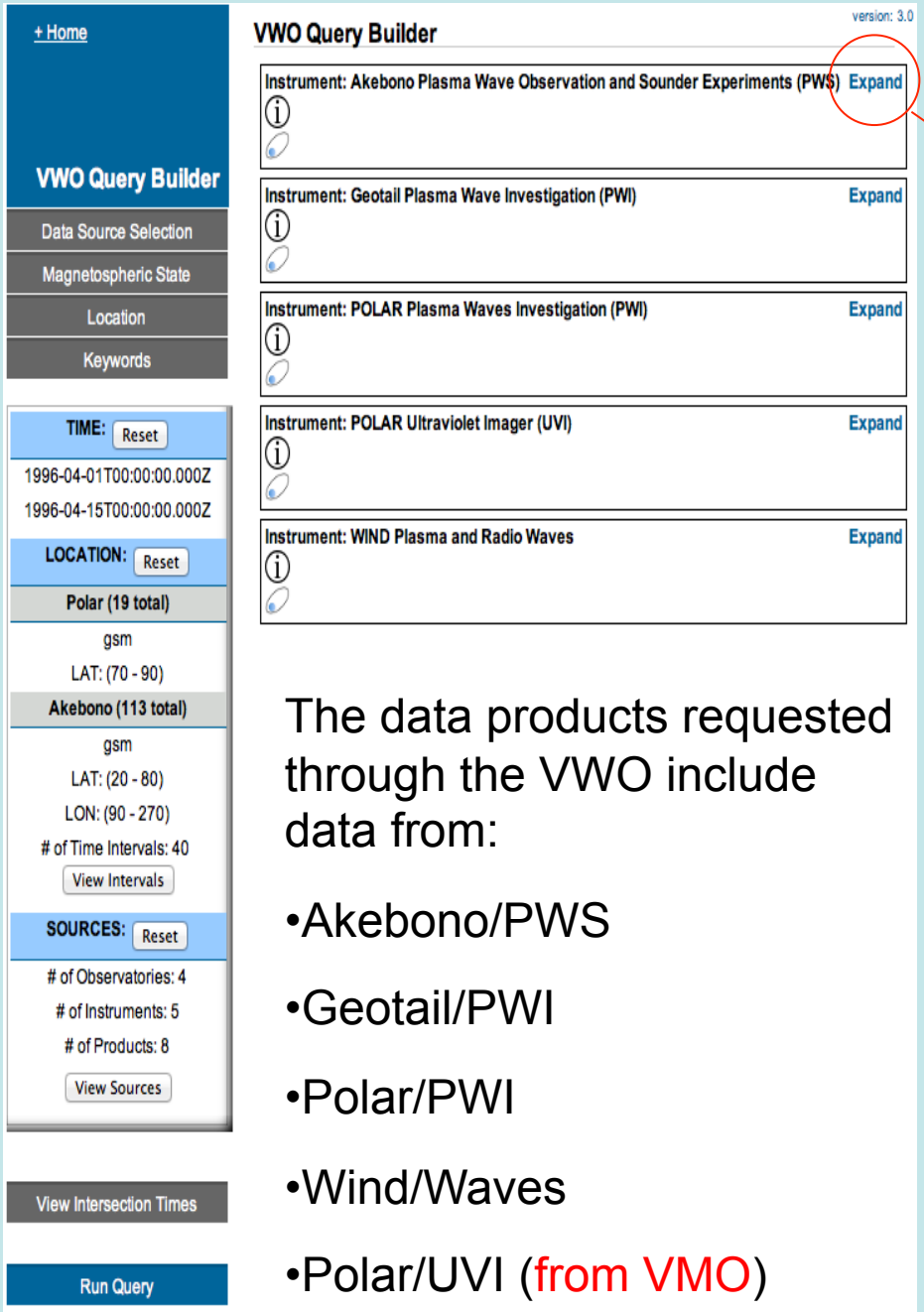
**Polar**

70 < Lat (GSM) < 90

**“View Intersection Times”**

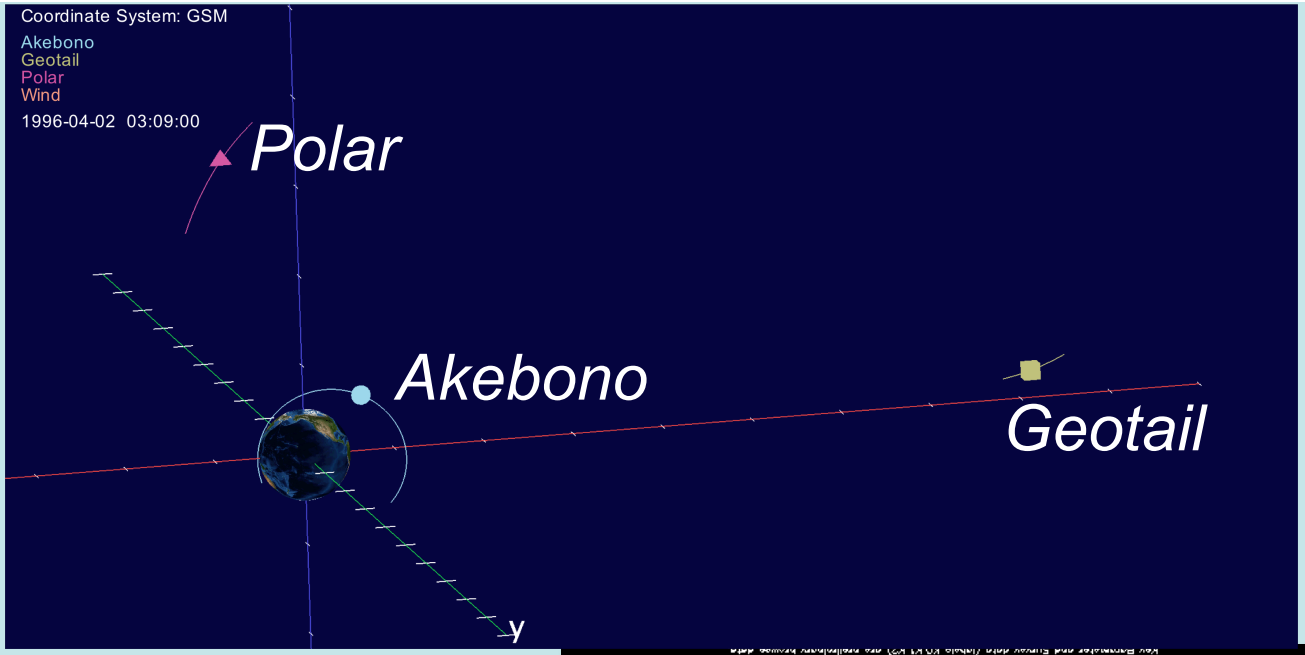
**Press “Run Query” to execute data search**





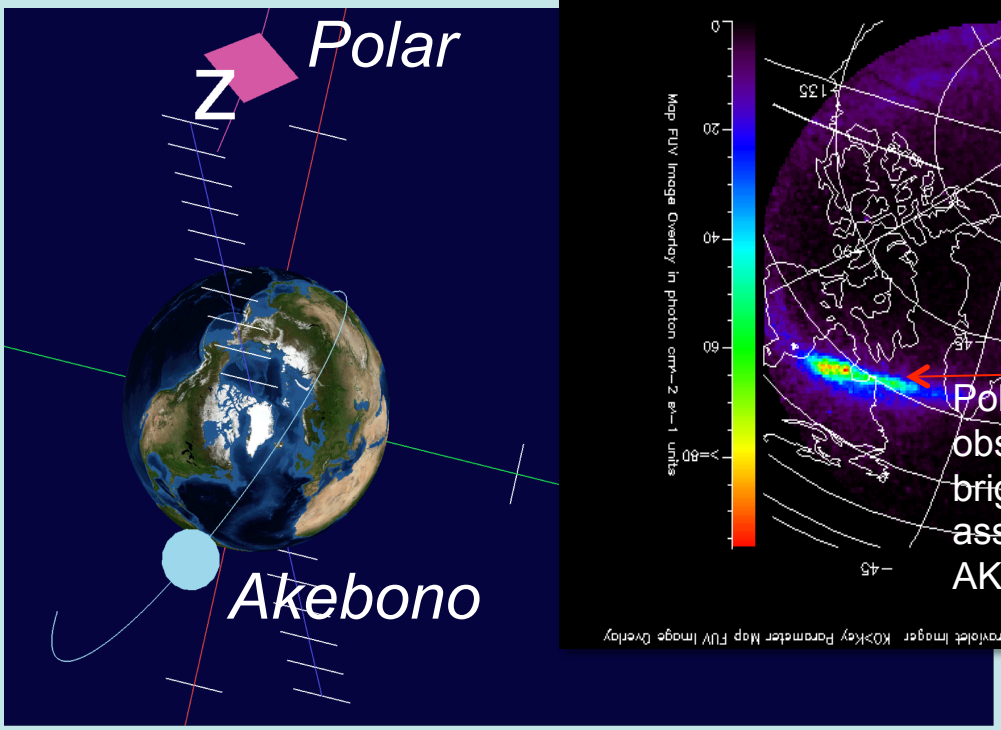

The data products requested through the VWO include data from:

- Akebono/PWS
- Geotail/PWI
- Polar/PWI
- Wind/Waves
- Polar/UVI (from VMO)



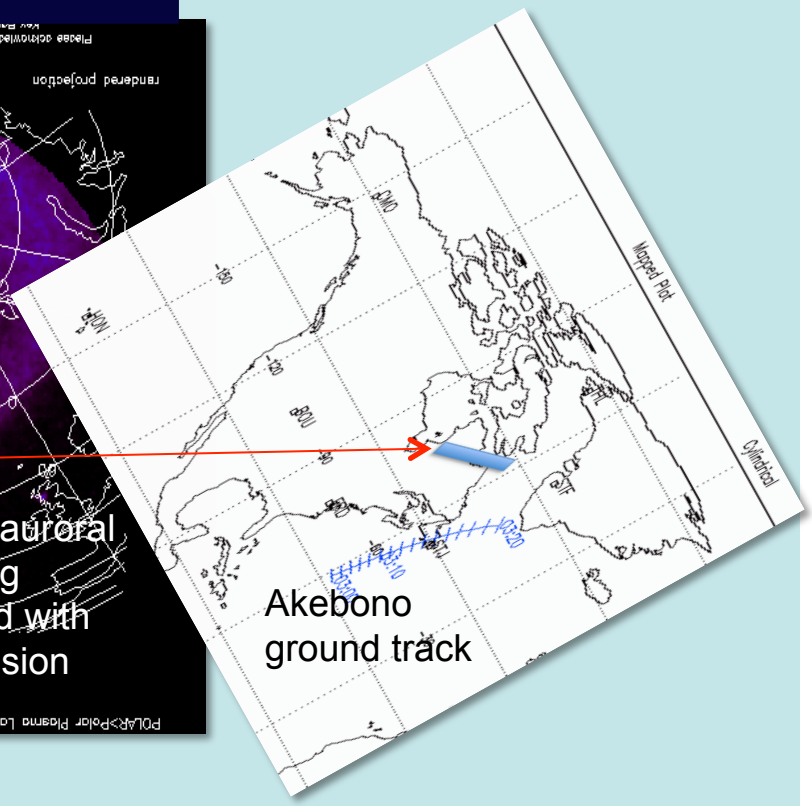

*Akebono*, *Polar*, Geotail, and Wind (not shown) in the "**same**" **meridional plane**

*Akebono* & *Polar* moving northward, *Geotail* moving inward near the equator



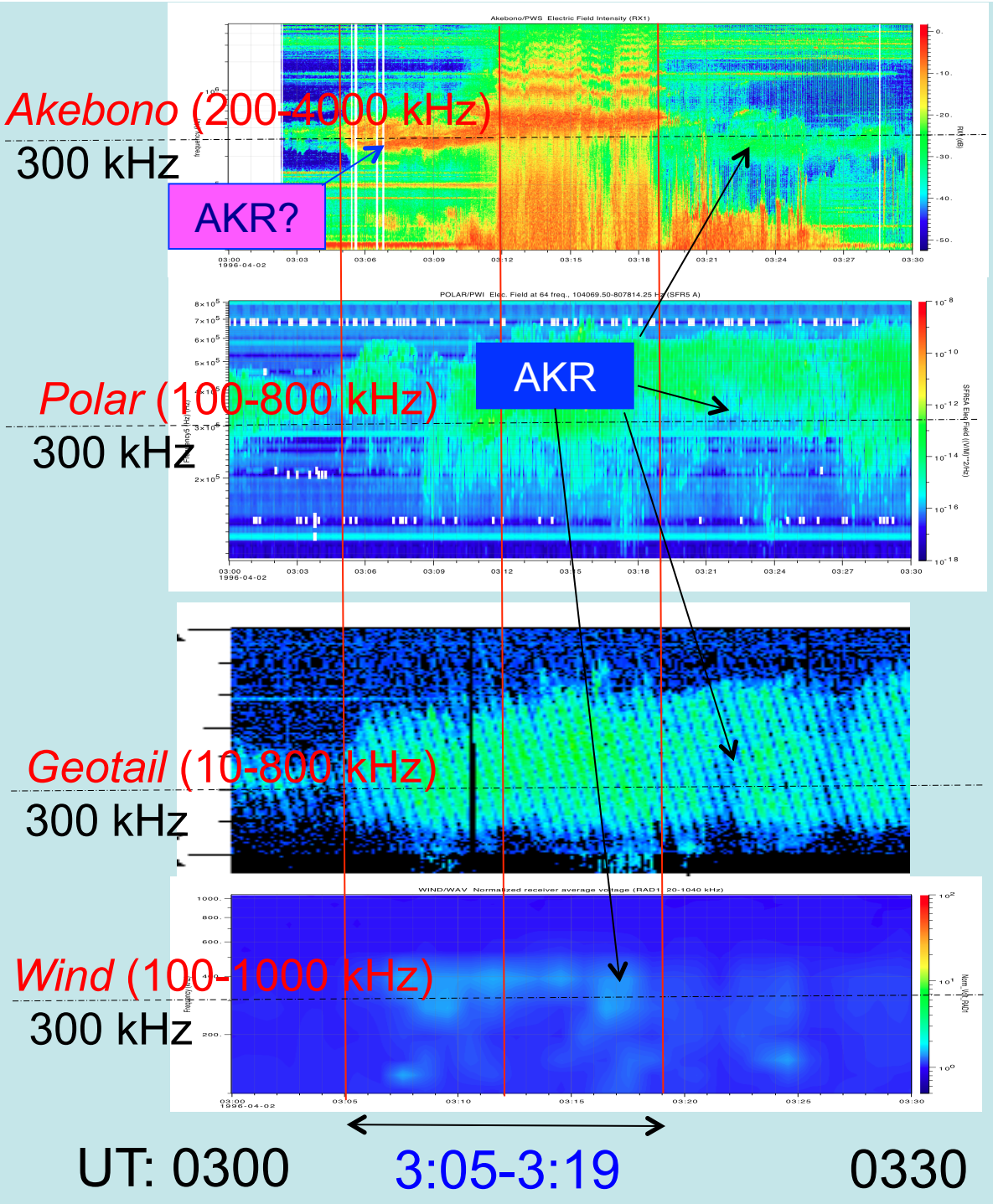






| Satellite @ 3:12 UT | GSM Lat | GSM Long | Rad. Dist |
|---|---|---|---|
| Akebono (night) | 49.3 | 175.3 | 1.74 |
| Polar (day) | 76.0 | 9.34 | 7.03 |
| Geotal (night) | 2.57 | 177.8 | 16.1 |
| Wind (day) | -1.31 | 355.2 | 69.3 |

All satellites in nearly the same meridian plane

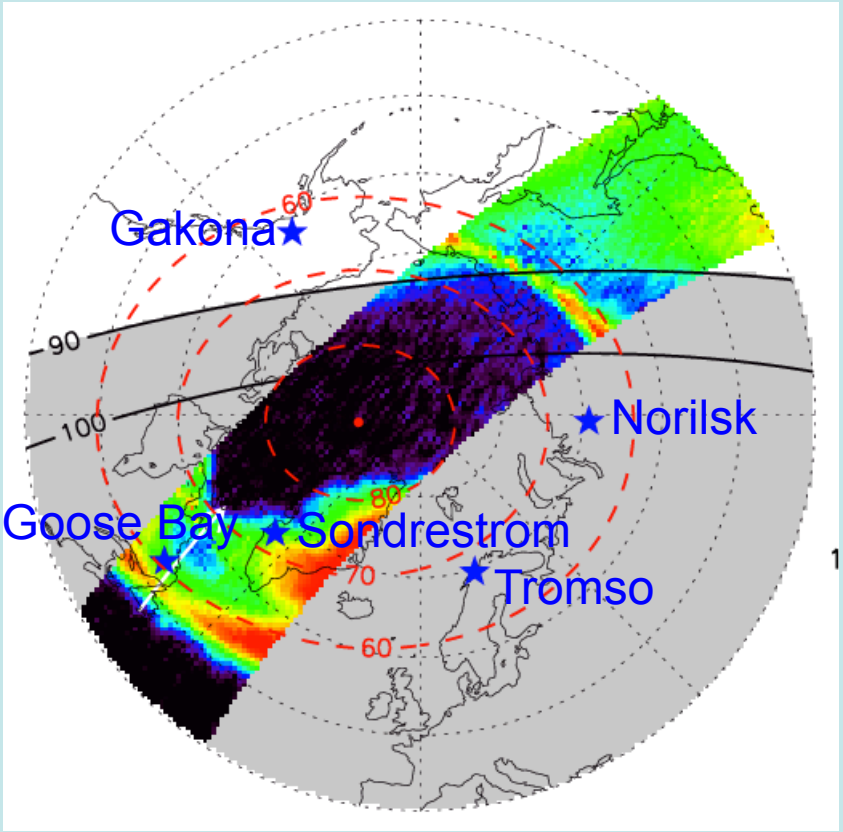


# Example 2: Validating FUV-Derived Auroral E-Region Electron Densities with Ionosonde Measurements

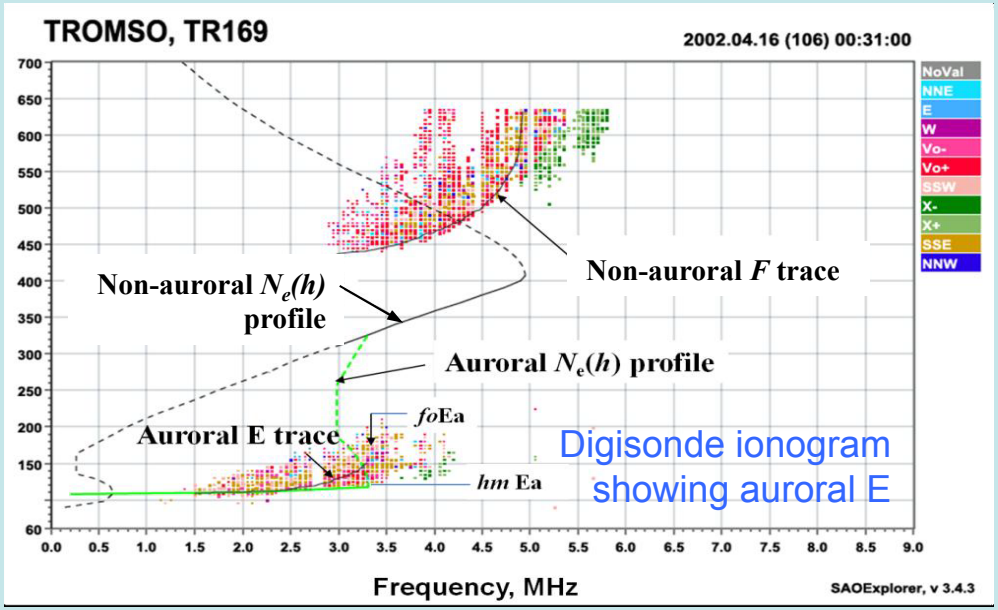
- Auroral FUV imaging observations, e.g., by the DMSP/SSUSI, can yield auroral E-region electron density information (NmEa, hmEa).
- The density information and models used to derive them can be validated by vertical density profiles measured by ground ionosondes during conjunction intervals.

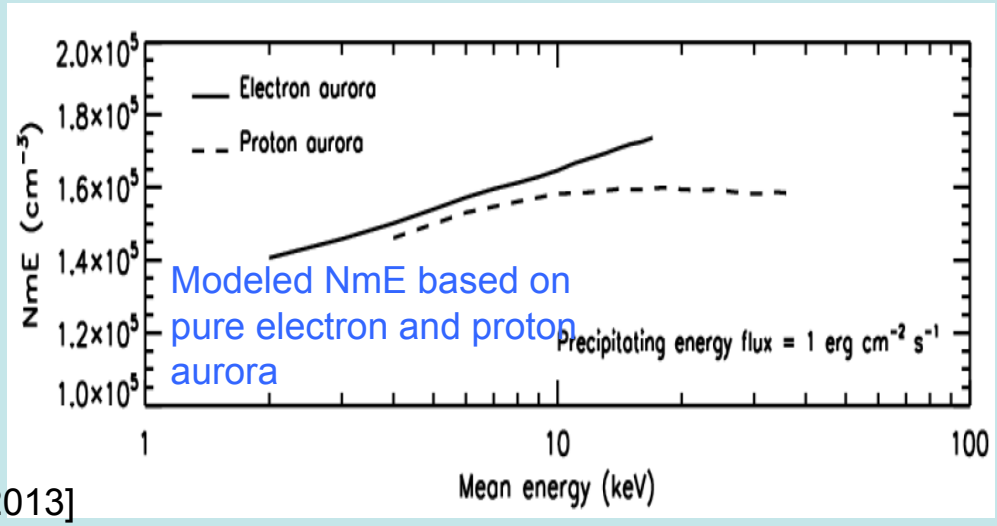
# Using *VWO* to search for Digisonde & FUV Conjunction Observations

Horizon-to-horizon SSUSI FUV scan
from DMSP F16
Nov 7, 2004 23:00UT




**Blue stars**: Digisonde locations in the oval



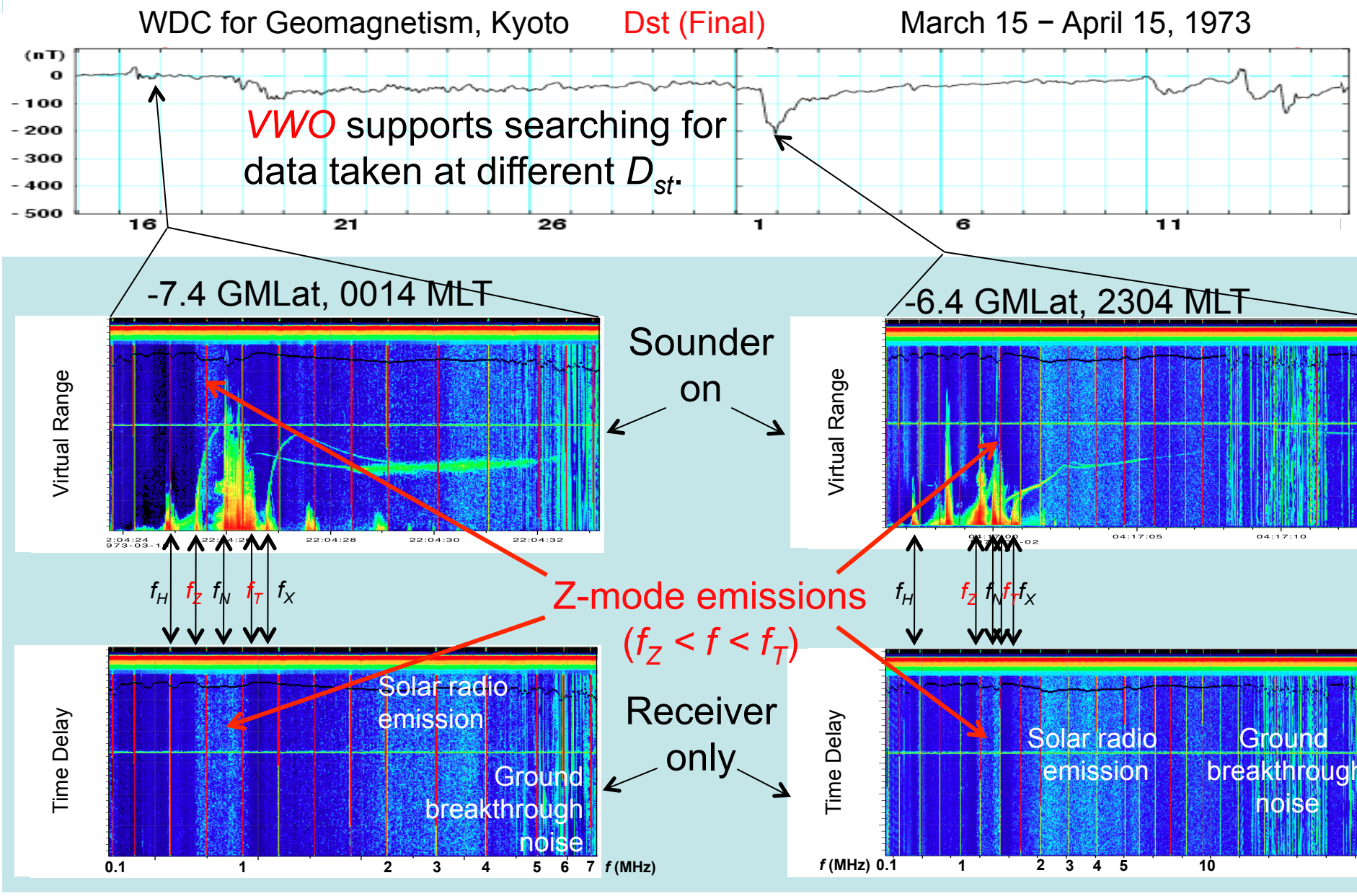




[Courtesy of H. Knight, Computational Physics, Inc., 2013]

# Example 3: Investigating Low-Latitude Topside Ionospheric Sounder Observations During Geomagnetic Storms

- Energetic electrons (> 30 keV) have been observed to penetrate to low-latitude topside ionosphere during geomagnetic storms.
- Equatorial precipitating particles can generate Z-mode emissions ($f_Z < f < f_T$) [*Benson, AGU,* 1991].
- Investigating Z-mode emissions in equatorial ionosphere (< 2000 Km) can help understand particle penetration at low latitudes.

# Near-Equatorial ISIS Ionograms ~1400 km



# Summary

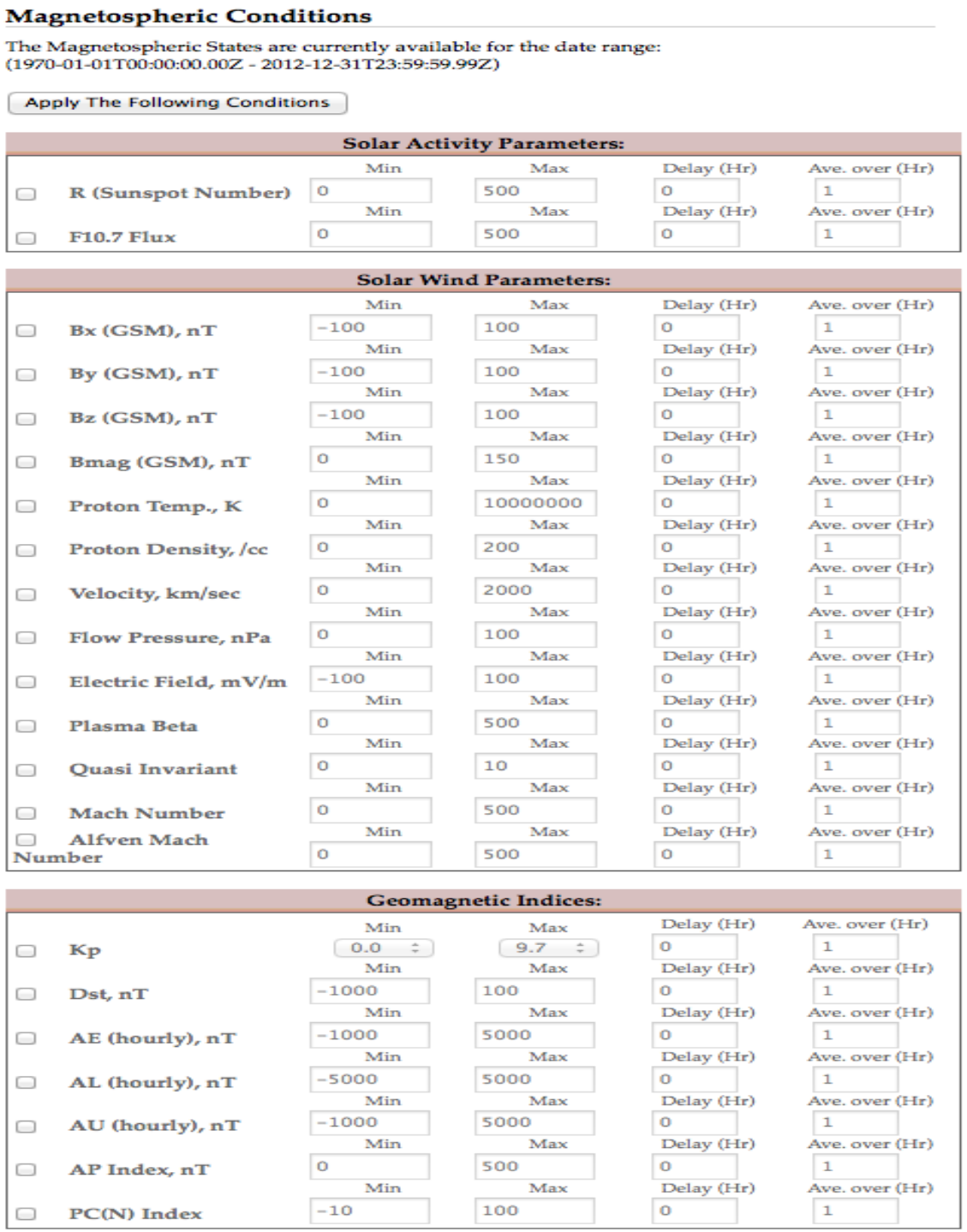
- The *NASA Virtual Wave Observatory* (*VWO*; <*http://vwo.nasa.gov*>) serves the world-wide, multi-diciplinary heliophysics community.
- Using *SPASE* and *SPASEQL* technology, *VWO* can search, access and display *online-accessible* (*distributed*) heliophyisics wave data and other *VxO*-accessible data.
- As shown by use examples, the *VWO can support science-based data searches* (time, platform, magnetospheric state, location).
- *VWO* welcomes your contributions to the growth of the metadata database and your feedback.
- The *VWO* can support *eScience* endeavors.

# Backups

# Search by Magnetopheric State Conditions

For a given time interval, a user can specify additional data-query conditons:

- Solar activity
- Solar wind/IMF parameters
- Geomagnetic conditions



**Magnetospheric Conditions**

The Magnetospheric States are currently available for the date range:
(1970-01-01T00:00:00.00Z - 2012-12-31T23:59:59.99Z)

Apply The Following Conditions

**Solar Activity Parameters:**

| | Min | Max | Delay (Hr) | Ave. over (Hr) |
|---|---|---|---|---|
| R (Sunspot Number) | 0 | 500 | 0 | 1 |
| F10.7 Flux | 0 | 500 | 0 | 1 |

**Solar Wind Parameters:**

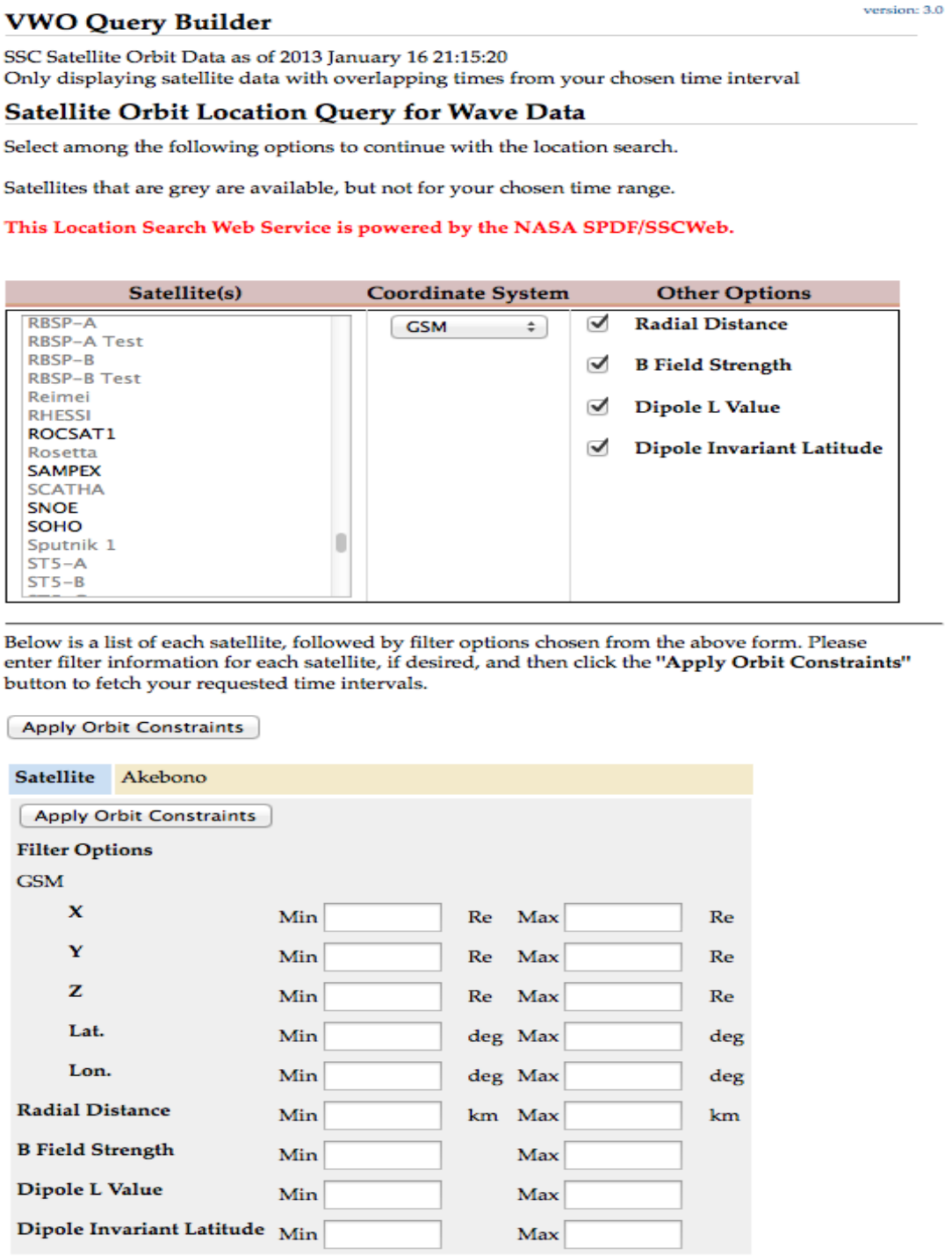
| | Min | Max | Delay (Hr) | Ave. over (Hr) |
|---|---|---|---|---|
| Bx (GSM), nT | -100 | 100 | 0 | 1 |
| By (GSM), nT | -100 | 100 | 0 | 1 |
| Bz (GSM), nT | -100 | 100 | 0 | 1 |
| Bmag (GSM), nT | 0 | 150 | 0 | 1 |
| Proton Temp., K | 0 | 10000000 | 0 | 1 |
| Proton Density, /cc | 0 | 200 | 0 | 1 |
| Velocity, km/sec | 0 | 2000 | 0 | 1 |
| Flow Pressure, nPa | 0 | 100 | 0 | 1 |
| Electric Field, mV/m | -100 | 100 | 0 | 1 |
| Plasma Beta | 0 | 500 | 0 | 1 |
| Quasi Invariant | 0 | 10 | 0 | 1 |
| Mach Number | 0 | 500 | 0 | 1 |
| Alfven Mach Number | 0 | 500 | 0 | 1 |

**Geomagnetic Indices:**

| | Min | Max | Delay (Hr) | Ave. over (Hr) |
|---|---|---|---|---|
| Kp | 0.0 | 9.7 | 0 | 1 |
| Dst, nT | -1000 | 100 | 0 | 1 |
| AE (hourly), nT | -1000 | 5000 | 0 | 1 |
| AL (hourly), nT | -5000 | 5000 | 0 | 1 |
| AU (hourly), nT | -1000 | 5000 | 0 | 1 |
| AP Index, nT | 0 | 500 | 0 | 1 |
| PC(N) Index | -10 | 100 | 0 | 1 |

# Search by Spacecraft Locations

- Location search is powered by the NASA Satellite Situation Center
- Data search based on observing spacecraft locations, local magntic field strengths, L values, or Invariant latitudes.



**VWO Query Builder** version: 3.0

SSC Satellite Orbit Data as of 2013 January 16 21:15:20
Only displaying satellite data with overlapping times from your chosen time interval

**Satellite Orbit Location Query for Wave Data**

Select among the following options to continue with the location search.

Satellites that are grey are available, but not for your chosen time range.

This Location Search Web Service is powered by the NASA SPDF/SSCWeb.

| Satellite(s) | Coordinate System | Other Options |
|---|---|---|
| RBSP-A<br>RBSP-A Test<br>RBSP-B<br>RBSP-B Test<br>Reimei<br>RHESSI<br>ROCSAT1<br>Rosetta<br>SAMPEX<br>SCATHA<br>SNOE<br>SOHO<br>Sputnik 1<br>ST5-A<br>ST5-B | GSM | ☑ Radial Distance<br>☑ B Field Strength<br>☑ Dipole L Value<br>☑ Dipole Invariant Latitude |

Below is a list of each satellite, followed by filter options chosen from the above form. Please enter filter information for each satellite, if desired, and then click the **"Apply Orbit Constraints"** button to fetch your requested time intervals.

Apply Orbit Constraints

**Satellite** Akebono

Apply Orbit Constraints

**Filter Options**

GSM

| | | | | | | |
|---|---|---|---|---|---|---|
| **X** | Min | | Re | Max | | Re |
| **Y** | Min | | Re | Max | | Re |
| **Z** | Min | | Re | Max | | Re |
| **Lat.** | Min | | deg | Max | | deg |
| **Lon.** | Min | | deg | Max | | deg |
| **Radial Distance** | Min | | km | Max | | km |
| **B Field Strength** | Min | | | Max | | |
| **Dipole L Value** | Min | | | Max | | |
| **Dipole Invariant Latitude** | Min | | | Max | | |